REMARKS/ARGUMENTS

Claims 1-10 and 11-27 remain in this application. Claims 1, 13, 21, and 24-26 have been amended. Claim 11 has been cancelled.

Claim 24 stands rejected under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The Examiner stated that the term "soliton" is being interpreted as "optical energy". However, the term "soliton" applies to a very special case of optical energy. The term "soliton" is well known in the art of optics. It's a pulse of optical energy that travels without changing its shape.

Applicants' attorney is including several references including pgs. 60-61 from the book entitled "Fiber Optics Communications", by Joseph Pallais, along with several papers that explain the solitons in more detail.

Claim 24 has been amended to state that the optical energy propagates as temporal soliton that has a wavelength within the photonic band gap. Accordingly, Applicants respectfully submit that claim 24 is not indefinite.

Claims 1, 4, 6-8, 13, 15, 17, 18 and 25-27 are rejected under 35 USC 103(a) as being unpatentable over Kawanishi et al (US 6,404,966 B1).

Applicant's claim 1 states that the core region with a loss of less than about 300 dB/km. The Examiner stated that Kawanishi et all teach an optical fiber where "The photonic band gap structure guides the optical energy substantially within the core region with loss of about 0.01 dB/km". This statement is different from that made in the cited reference. Col. 3, lns. 39-42 of the Kawanishi state that "The optical fiber according to the present embodiment can be expected to have a loss characteristic of about 0.01 dB/km".

That is, the reference never disclosed such fiber, the Kawanishi et al was simply hoping that the fiber would be capable of this performance. In fact it is not. Because it requires more than

an air filled core to achieve this performance, and because Kawanishi et all does not describe these factors, this statement is akin to telling those of skill in the art to look for a needle in the haystack. The Kawanishi reference does not disclose an enabling embodiment that allows the fiber have a loss characteristic of about 0.01 dB/km.

Therefore, claim 1 is not obvious over the Kawanishi reference.

Furthermore, claim 1 has been amended to include the subject matter of the original claim 11, which states that "the optical energy is guided in a mode having a nonlinear refractive index of less than about 10^{-18} cm^2/W."

This parameter contributes to the low loss and is not taught or disclosed by the cited reference. In fact, pg. 7, paragraph [0033] of the Applicants specification discloses that in typically the guided modes have effective nonlinear refractive indices n_2 ranging from $2x10^{-16}$ cm^2/W to $4x10^{-16}cm^2/W$ while some of the claims call for it being less than 10^{-18} cm^2/W. This is at least a factor of 10 different (20 times less) than that of the known fibers.

Claims 4, 6-8 13, 15, 17 and 18 depend from claim 1 as their base claim and, therefore, explicitly incorporate the language of claim 1. Accordingly Applicants respectfully submit that claims 1, 4, 6-8 13, 15, 17 and 18 are not obvious over the Kawanishi reference.

Claims 25-27 (and 13) state that the "optical fiber is configured to support a temporal soliton having a peak power of greater than about 1 MW". Such fiber is not disclosed by the Kawanishi reference, and the Kawanishi reference provides no incentive for having a fiber with this characteristics. Accordingly, claims 13 and 25-27 are not obvious over this reference.

Claims 1-3, 5, 6-10, 13, 14, 16-18 and 25-27 are rejected under 35 USC 103(a) as being unpatentable over Libori et al (US 6,792,188 B2).

Although Libori makes a statement that a low loss fiber is desirable, Libori does not define what is meant by a "low loss", nor provides an enabling embodiment that has the losses in the Applicant's claimed range. A mere statement that something is desirable, without a way of how to achieve such a result, does not constitute an enabling disclosure. The conditions for

achievement of loss less than 300 dB/km (or less than 50 dB/km, or less than 20 dB/km) were disclosed by the Applicants and were not known to one of ordinary skill in the art, although the was a long felt need to have a fiber with these characteristics.

Furthermore, as stated above, Claims 25-27 call for the "optical fiber is configured to support a temporal soliton having a peak power of greater than about 1 MW". Such fiber is not disclosed by the Liborui reference, and the reference provides no incentive for having a fiber with this characteristics.

Accordingly, claims 1-3, 5, 6-10, 13, 14, 16-18 and 25-27 are not unpatentable over Libori, et al.

Claims 1, 4, 6, 7, 11, 12, 15 and 19-27 are rejected under 35 USC 103(a) as being unpatentable over Fajardo et al (US 6,444,133 B1).

The Fajardo reference does not disclose the fiber with ether a loss of a loss of less than about 300 dB/km, less than 50 dB/km, etc, or that has a nonlinear refractive index of less than about 10^{-18} cm^2/W, or less than $5x10^{-19}$ cm^2/W. As stated above according to applicant's claims, this nonlinear refractive index of one to two orders of magnitude smaller than similar known fibers (and certainly not within general ranges disclosed by prior art fiber references), and this characteristic has not been disclosed in any of the cited reference. Since the cited references, neither singly, nor in combination do not recite optical fiber with this feature, claims 1, 4, 6, 7, 11, 12, 15 and 19-27 (or other claim) are not obvious over Fajardo, or other cited references.

Conclusion

Based upon the above amendments, remarks, and papers of records, applicant believes the pending claims of the above-captioned application are in allowable form and patentable over the prior art of record. Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Applicant believes that no extension of time is necessary to make this Reply timely. Should applicant be in error, applicant respectfully requests that the Office grant such time extension

pursuant to 37 C.F.R. § 1.136(a) as necessary to make this Reply timely, and hereby authorizes the Office to charge any necessary fee or surcharge with respect to said time extension to the deposit account of the undersigned firm of attorneys, Deposit Account 03-3325.

Please direct any questions or comments to Svetlana Z. Short at 607-974-0412.

Respectfully submitted,

Svetlana Short

DATE: 8/17/06

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where the slope M_0 is approximately -0.095 ps/(nm^2 × km), λ_0 is the zero-dispersion wavelength, and all wavelengths are in nm. Values of M_0 and λ_0 are often given by the fiber manufacturer. The minus sign is needed because of the negative slope of the dispersion curve. Some reverse the sign conventions followed in this section, so that their dispersion curves have a positive slope and the minus sign is missing in Eq. (3-14).

Example 3-3

Compute the material dispersion at 1.55 μm if the zero-dispersion wavelength is 1.3 μm.

Solution:

It is most straightforward to solve the preceding equation by using the wavelengths expressed in nm. Otherwise, the slope coefficient M_0 would have to be converted into the appropriate units. Thus

$$M = \frac{-0.095}{4}\left(1550 - \frac{1300^4}{1550^3}\right)$$
$$= -18.6 \text{ ps/(nm} \times \text{km)}$$

a result that checks nicely with the value obtained directly from Fig. 3-8.

Example 3-4

Compute the pulse spread when the light source emits at 1320 nm and has a 2-nm spectral width. The zero-dispersion wavelength is 1300 nm.

Solution:

The dispersion turns out to have a magnitude of 1.86 ps/(nm × km), so that Eq. (3-14) yields a spread of $\Delta(\tau/L) = 2 \times 1.86 = 3.72$ ps/km. A 10-km length of this material would produce a pulse spread of only 37.2 ps = 0.0372 ns, considerably smaller than that computed in Examples 3-1 and 3-2 for propagation at wavelengths farther away from the dispersion minimum.

Solitons

Pulse spreading reduces the bandwidth and data capacity of a fiber communications link in the manner described later in this section. Because of this, many techniques for minimizing pulse spreading have been pursued. A few that we already know about are (1) operating at the zero-dispersion wavelength and (2) choosing very coherent (small spectral width) light sources. These solutions (often applied together) have been common since the mid-1980s. Improvements now take the form of shifting the fiber's zero-dispersion point to wavelengths of lower fiber attenuation and producing more coherent laser sources.

Another technique that shows promise for reducing pulse spreading is the production of *solitons*.[3] A soliton is a pulse that travels along a fiber without changing shape. How can this happen? The actual procedure is fairly complicated, but some insight into soliton propagation can be easily developed. Pulses broaden because dispersion causes some wavelengths emitted by the light source to travel faster than other wavelengths. All we need do is find some property of the fiber that counters this tendency. It turns out that such a property does exist. It is a fiber nonlinearity where the index of refraction depends upon the intensity of the light beam. Since the pulse velocity depends on the index of refraction, it is clear that the intensity of the beam can itself influence the speed of the various wavelengths propagating along the fiber. Usually this phenomenon is not observed, because it is quite small and requires a moderately large amount of optical power before becoming significant.

To form a soliton, the initial pulse must have a particular peak energy and pulse shape.

To be specific, the product of pulse energy and pulse width must be a constant. The value of the constant depends on the magnitudes of the dispersion and the nonlinearity. With too little power, the nonlinearity is too weak to be effective in compensating for dispersion. If the power is too great, then the pulse may actually continually change widths as it travels, owing to imperfect (and distance-dependent) compensation. In addition, the nonlinear compensation is such that solitons are produced only at wavelengths longer than the zero-dispersion wavelength in glass fibers. That is, the nonlinearity acts with dispersion to further broaden pulses at the shorter wavelengths and only compensates at the longer ones. We conclude that soliton pulses can be expected in silica fibers only when operating in the 1300- to 1600-nm range.

Although solitons retain pulse widths during propagation, solitons do attenuate just like other waves. It will be imperative for long systems that the optical beam be amplified periodically so that the pulse energy not fall below that required for soliton maintenance. Various optical amplifiers (to be described in Section 6-7) are candidates for the amplification process.

Soliton widths of a few picoseconds are realizable. The corresponding data rates (the inverse of the soliton widths) are over 10 Gbps. Multigigabit-per-second systems covering many thousand kilometers with amplifier spacings of several tens of kilometers can be designed with soliton pulses. The product of data rate and fiber path length for such systems is far greater than can be achieved by more conventional fiber techniques.

Information Rate

Pulse spreading limits the information capacity of any transmission system in the manner described in what follows. For numerical calculations we will use the spreads generated by material dispersion. The equations developed apply regardless of the cause of the distortion. We will investigate the limits on both analog and digital links. Without long and complex derivations, exact results cannot be obtained. Reasonable limits can be developed based on approximate intuitive analyses. The results obtained will be useful in first-order design and will deepen understanding of the ability of fiber links to carry information.

First, consider a sinusoidally modulated beam of light (like that shown in Fig. 3-5). The modulation frequency is f and the period is $T = 1/f$. Suppose that the source radiates optic wavelengths between λ_1 and λ_2. How much delay between the fastest and slowest wavelength is acceptable? Figure 3-9 shows the received power at λ_1 and λ_2 when the delay is equal to half the modulation period; that is,

$$\Delta\tau = \frac{T}{2} \tag{3-15}$$

With this amount of delay, the modulation cancels out completely when the two waves are added. Modulated power carried at wavelengths between λ_1 and λ_2 will have delays smaller than $T/2$ and will partially cancel, resulting in a small signal variation at the receiver. If we take Eq. (3-15) as the maximum

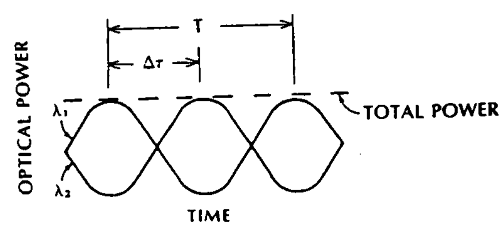

Figure 3-9 Canceling of the modulation when two carrier wavelengths have a delay of half the modulation period. $\Delta\tau = T/2$.

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A B C D E F G H I J K L M
N O P Q R S T U V W X Y Z

Solitons

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Definition: pulses with a certain balance of nonlinear and dispersive effects

In general, the temporal and spectral shape of a short optical pulse changes during propagation in a transparent medium due to the Kerr effect and dispersion. Under certain circumstances, however, the effects of Kerr nonlinearity and dispersion can exactly cancel each other, apart from a constant phase delay per unit propagation distance, so that the temporal and spectral shape of the pulses is preserved even over long propagation distances. The conditions for that to happen are:

- For a positive value of the nonlinear coefficient n_2 (as is usual for mos… media) the dispersion needs t…
- The ten… has to be that of an unchirped sech^2 pulse (assuming that the group delay dispersion is constant):

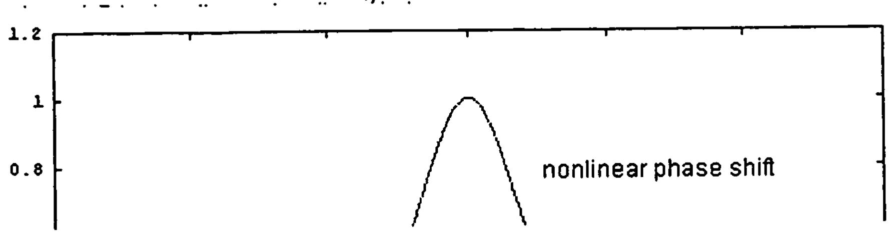
$$P(t) = P_p \,\mathrm{sech}^2(t/\tau) = \frac{P_p}{\cosh^2(t/\tau)}$$

τ

- The pulse energy E_p and soliton pulse duration have to meet the following condition:

$$E_p = \frac{2|D|}{|\gamma|\tau}$$

Here, the full-width-at-half-maximum pulse duration is about 1.76 times , γ is the SPM coefficient (in rad per Watt and



peak of the pulse would experience if only the nonlinearity alone would act on it. This soliton phase shift is constant over time or frequency, i.e., it does not lead to a chirp, and it is in many situations not relevant.

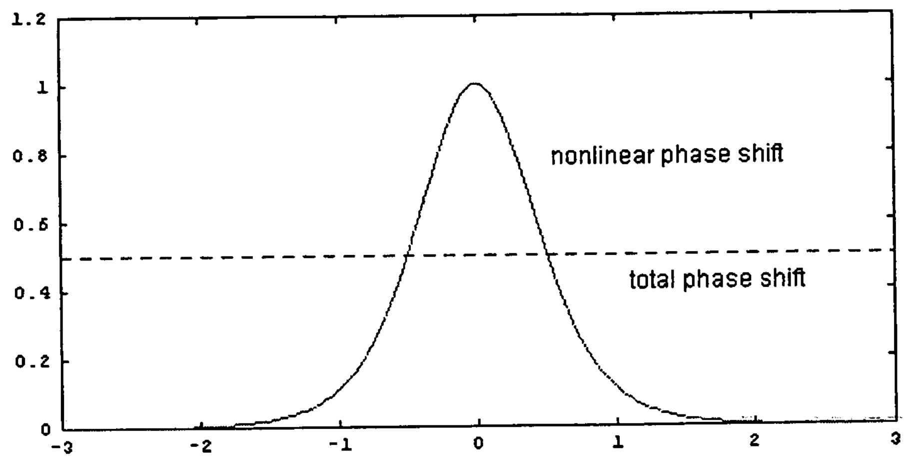


Fig.: Solid curve: time-dependent nonlinear phase shift alone (without dispersion), which is proportional to the optical intensity. Dotted curve: overall phase shift, resulting from the combined action of nonlinearity and dispersion on a soliton. The constant phase shift does not modify the temporal or spectral shape of the pulse.

The most remarkable fact is actually not the possibility of such a balance of dispersion and nonlinearity, but rather the fact that soliton solutions of the nonlinear wave equation are very stable: even for substantial deviations of the initial pulse from the exact soliton solution, the pulse automatically "finds" the correct soliton shape while shredding some of its energy into a so-called dispersive wave, a weak background which has too little intensity to experience significant nonlinear effects and temporally broadens as a result of dispersion. Solitons are also very stable against changes of the properties of the medium, provided that these changes occur over distances which are long compared to the so-called soliton period (defined as the propagation distance in which the constant phase delay is π/4). This means that solitons can adiabatically adapt their shape to slowly varying parameters of the medium. Also, solitons can accommodate to some amount of higher-order dispersion; they then automatically adjust their shape to

then automatically adjust their shape to achieve the mentioned balance under the given conditions.

If the pulse energy is the square of an integer number times the fundamental soliton energy, one has a so-called higher-order soliton. Such pulses do not have a preserved shape, but their shape periodically varies, with the period being the above mentioned soliton period. However, higher-order solitons can break up into fundamental solitons under the influence of higher-order dispersion and other disturbing effects. They are by far not as stable as fundamental solitons.

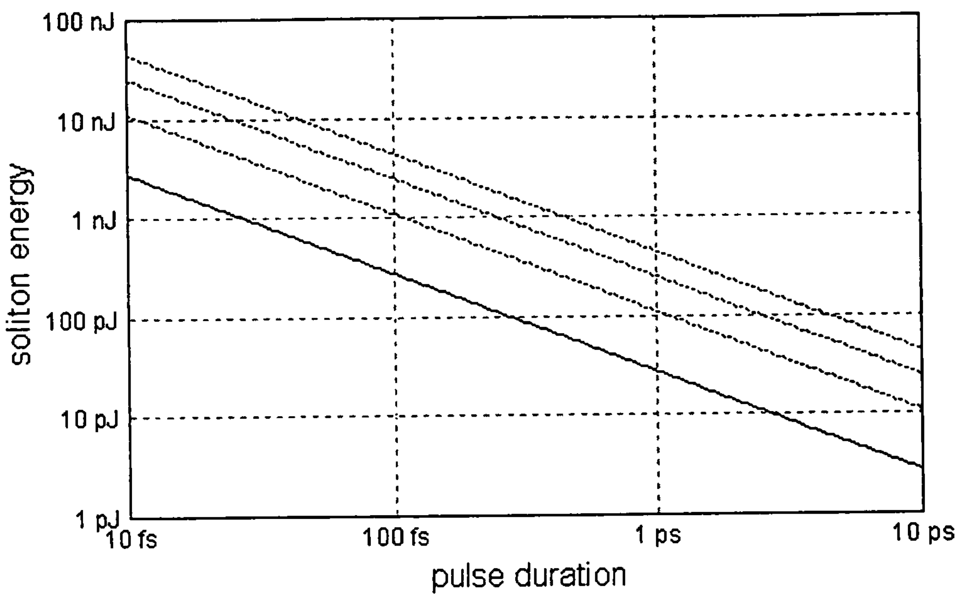


Fig.: Relation between soliton pulse energy and pulse duration in a single-mode fiber. The solid curve applies to fundamental solitons, the dotted curves to higher-order solitons (orders 2, 3, 4).

Fundamental soliton pulses are technically very important, in particular for long-distance optical fiber communications and in mode-locked lasers (→ soliton mode locking). In the latter situation, soliton-like pulses can be formed when the typically lumped pieces of dispersion and nonlinearity in the laser cavity are sufficiently weak per cavity round trip. Solitons are also applied in various techniques for pulse compression using optical fibers; an example is adiabatic soliton compression.

Soliton propagation, possibly with additional disturbing effects, can be investigated with numerical simulations (→ pulse propagation modeling). These

(→ pulse propagation modeling). There are also some analytical tools, e.g. *soliton perturbation theory*, where one derives equations for small deviations of pulses from the ideal soliton shape.

Apart from the temporal solitons as discussed above, there are also *spatial solitons*. In that case, a nonlinearity of the medium (possibly of photorefractive type) cancels the diffraction, so that a beam with constant beam radius can be formed even in a medium which would be homogeneous without the influence of the light beam.

References

[1] L. F. Mollenauer, R. H. Stolen, and J. P. Gordon, "Experimental observation of picosecond pulse narrowing and solitons in optical fibers", Phys. Rev. Lett. 45, 1095 (1980)

See also: Kerr effect, dispersion, soliton period, $sech^2$-shaped pulses, higher-order solitons, adiabatic soliton compression, pulse compression, Gordon-Haus jitter, pulse propagation modeling

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Quasi-soliton pulses

Definition: soliton-like pulses in lasers or fiber-optic links

Optical pulses circulating in the cavity of a mode-locked laser can experience chromatic dispersion and the Kerr nonlinearity. If the dispersion is anomalous, this can lead to the formation of quasi-soliton pulses. These are not exactly solitons, since the dispersion and nonlinearity usually come in discrete portions, and the pulse energy varies during a cavity round trip. Nevertheless, the pulses may behave like solitons if the effects of dispersion and nonlinearity are not too strong during one round trip, and other effects are still weaker. One can then exploit the advantages of soliton mode locking, namely the generation of rather short pulses with low chirp.

A special kind of quasi-soliton pulses has been discovered in semiconductor lasers, particularly in vertical external cavity surface-emitting lasers (VECSELs). Here, the effect of the Kerr nonlinearity is usually rather weak, but light-induced changes of the carrier density can lead to nonlinear phase changes which are similar to those from the Kerr effect with negative n_2 coefficient, even though they do not instantly follow the variations of optical intensity. In that case, quasi-soliton pulses can be formed in the *normal* dispersion regime. A consequence is that the pulses can be close to the Fourier transform limit.

Soliton-like pulses also occur in fiber-optic links.

Reference:

- R. Paschotta et al., "Soliton-like pulse shaping mechanism in passively mode-locked surface-emitting semiconductor lasers", Appl. Phys. B 75, 445 (2002)

See also: solitons, mode locking, soliton mode locking

Changes to problems 3 and 4 from HW #5 and a modest simplification.

The changes.

(i) Agrawal and many others use T_0 instead of the intensity FWHM pulse width τ dispersion lengths where T_0 is the characteristic time for a sech pulse accordir $E = E_o \operatorname{sech}(t/T_0)$. As given in the class notes, $\tau_p = 1.763 * T_0$ for a sech pulse. dispersion lengths are defined as:

$$L_D = \frac{T_0^2}{\beta_2} \quad and \quad L'_D = \frac{T_0^3}{\beta_3}$$

The homework problem specifies a Gaussian pulse with τ_p = 100 fs so it makes characteristic time for a Gaussian T_0 defined by $E = E_0 \exp[-t^2/T_0^2]$. In this cas $\tau_p = 1.665 * T_0$ to find T_0, but people often use the relation for a sech pulse anyway. isn't large, so do as you see fit. Just make clear what your choice is.

The reason for the emphasis on sech **pulses** is that **soliton pulses** have a sech profile. S interesting in their own right and are of key interest for high-speed communications. ✓

(ii) I'd like to change the information requested as well.

(a) Plot the spectral phase at z=L in addition to the other plots.

(b) Use a medium length of π/2 and π and don't worry about plotting the spectrum. Thi you see what is going on, especially if you look at lengths intermediate between z z = π/2. You might want to take a second look at the notes section on solitons and **definition** of "N".

The simplification. You can do the following instead if you like:

The NSE is:

$$\frac{\partial A}{\partial z} = -\frac{i}{2}\beta_2 \frac{\partial^2 A}{\partial \tau^2} + \frac{1}{6}\beta_3 \frac{\partial^3 A}{\partial \tau^3} + i\gamma |A|^2 A$$

where A(z,τ) is the electric field envelope. Recall we have $A(z,\tau) = \sqrt{P_o}\, U(z,\tau)$,

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so·lil·o·quize \-ˌkwīz\ *vi* -quized; -quiz·ing (1759) : to utter a soliloquy : talk to oneself — so·lil·o·quiz·er *n*

so·lil·o·quy \sə-ˈlil-ə-kwē\ *n, pl* -quies [LL *soliloquium*, fr. L *solus* alone + *loqui* to speak] (ca. 1604) 1 : the act of talking to oneself 2 : a dramatic monologue that gives the illusion of being a series of unspoken reflections

so·lip·sism \ˈsō-ləp-ˌsiz-əm, ˈsäl-əp-\ *n* [L *solus* alone + *ipse* self] (1874) : a theory holding that the self can know nothing but its own modifications and that the self is the only existent thing — so·lip·sist \ˈsō-ləp-sist, ˈsäl-əp-, sə-ˈlip-\ *n* — so·lip·sis·tic \ˌsō-ləp-ˈsis-tik, ˌsäl-əp-\ *adj* — so·lip·sis·ti·cal·ly \-ti-k(ə-)lē\ *adv*

sol·i·taire \ˈsäl-ə-ˌta(ə)r, -ˌte(ə)r\ *n* [F, fr. *solitaire*, adj., solitary, fr. L *solitarius*] (1727) 1 : a single gem (as a diamond) set alone 2 : any of various card games that can be played by one person

sol·i·tary \ˈsäl-ə-ˌter-ē\ *adj* [ME, fr. L *solitarius*, fr. *solitas* aloneness, fr. *solus* alone] (14c) 1 a : being, living, or going alone or without companions b : saddened by isolation 2 : UNFREQUENTED, DESOLATE 3 : taken, passed, or performed without companions ⟨a ~ ramble⟩ 4 : being at once single and isolated ⟨a ~ example⟩ 5 a : occurring singly and not as part of a group or cluster ⟨flowers terminal and ~⟩ b : not gregarious, colonial, social, or compound ⟨~ bees⟩ *syn* see ALONE — sol·i·tari·ly \ˌsäl-ə-ˈter-ə-lē\ *adv* — sol·i·tari·ness \ˈsäl-ə-ˌter-ē-nəs\ *n*

solitary *n, pl* -tar·ies (15c) 1 : one who lives or seeks to live a solitary ~~life : RECLUSE 2 : solitary confinement in prison~~

sol·i·tons \ˈsäl-ə-ˌtänz\ *n pl* [*solitary* + ²*-on*] (ca. 1975) : solitary waves (as in a gaseous plasma) that retain their shape and speed after colliding with each other

sol·i·tude \ˈsäl-ə-ˌt(y)üd\ *n* [ME, fr. MF, fr. L *solitudin-*, *solitudo*, fr. *solus*] (14c) 1 : the quality or state of being alone or remote from society : SECLUSION 2 : a lonely place (as a desert)

syn SOLITUDE, ISOLATION, SECLUSION mean the state of one who is alone. SOLITUDE may imply a condition of being apart from all human beings or of being cut off by wish or compulsion from one's usual associates; ISOLATION stresses detachment from others often involuntarily; SECLUSION suggests a shutting away or keeping apart from others often connoting deliberate withdrawal from the world or retirement to a quiet life.

sol·i·tu·di·nar·i·an \ˌsäl-ə-ˌt(y)üd-ᵊn-ˈer-ē-ən\ *n* [L *solitudin-*, *solitudo* + E *-arian*] (1691) : RECLUSE

sol·ler·et \ˌsäl-ə-ˈret\ *n* [F] (1826) : a flexible steel shoe forming part of a medieval suit of armor — see ARMOR illustration

sol·mi·za·tion \ˌsäl-mə-ˈzā-shən\ *n* [F *solmisation*, fr. *solmiser* to sol-fa, fr. *sol* (fr. ML) + *mi* (fr. ML) + *-iser* -ize] (1730) : the act, practice, or system of using syllables to denote the tones of a musical scale

¹so·lo \ˈsō-(ˌ)lō\ *n, pl* solos [It, fr. *solo* alone, fr. L *solus*] (1695) 1 *or pl* so·li \ˈsō-(ˌ)lē\ a : a musical composition for a single voice or instrument with or without accompaniment b : the featured part of a concerto or similar work 2 : a performance in which the performer has no partner or associate 3 : any of several card games in which a player elects to play without a partner against the other players

²solo *adv* (1712) : without a companion : ALONE ⟨fly ~⟩

³solo *adj* (1776) : of, relating to, or being a solo ⟨a ~ performance⟩

⁴solo *vi* so·loed; so·lo·ing \-(ˌ)lō-iŋ, -lə-wiŋ\ (1886) : to perform by oneself; *esp* : to fly an airplane without one's instructor

so·lo·ist \ˈsō-lə-wəst, -(ˌ)lō-əst\ *n* (1864) : one who performs a solo

Sol·o·mon \ˈsäl-ə-mən\ *n* [LL, fr. Heb *Shĕlōmōh*] : a son of David and 10th century B.C. king of Israel proverbial for his wisdom

Sol·o·mon·ic \ˌsäl-ə-ˈmän-ik\ *adj* (1857) : marked by notable wisdom, reasonableness, or discretion esp. under trying circumstances

Solomon's seal *also* Sol·o·mon·seal \ˌsäl-ə-mən-ˈsē(ə)l, ˈsäl-ə-mən-ˌ\ *n* (1543) 1 : any of a genus (*Polygonatum*) of perennial herbs of the lily family with gnarled rhizomes 2 : an emblem consisting of two interlaced triangles forming a 6-pointed star and formerly used as an amulet esp. against fever

so·lon \ˈsō-lən, -ˌlän\ *n* [*Solon*] (1625) 1 : a wise and skillful lawgiver 2 : a member of a legislative body

sol·on·chak \ˌsäl-ən-ˈchak\ *n* [Russ, salt marsh] (1936) : any of a group of intrazonal strongly saline usu. pale soils found esp. in poorly drained arid or semiarid areas

sol·o·netz *also* sol·o·nets \ˌsäl-ə-ˈnets\ *n* [Russ *solonets* salt not extracted by decoction] (1936) : any of a group of intrazonal dark hard alkaline soils evolved by leaching and alkalizing from solonchak — sol·o·netz·ic \-ˈnet-sik\ *adj*

so long \sō-ˈlȯŋ, sə-\ *interj* [origin unknown] (ca. 1850) — used to express farewell

so long as *conj* (15c) 1 : during and up to the end of the time that : WHILE 2 : provided that

sol·stice \ˈsäl-stəs, ˈsōl-, ˈsȯl-\ *n* [ME, fr. OF, fr. L *solstitium*, fr. *sol* sun + *status*, pp. of *sistere* to come to a stop, cause to stand; akin to L *stare* to stand — more at SOLAR, STAND] (13c) 1 : one of the two points on the ecliptic at which its distance from the celestial equator is greatest and which is reached by the sun each year about June 22d and December 22d 2 : the time of the sun's passing a solstice which occurs about June 22d to begin summer in the northern hemisphere and about December 22d to begin winter in the northern hemisphere

sol·sti·tial \säl-ˈstish-əl, sōl-, sȯl-\ *adj* [L *solstitialis*, fr. *solstitium*] (1559) 1 : of, relating to, or characteristic of a solstice and esp. the summer solstice 2 : happening or appearing at or associated with a solstice

sol·u·bil·i·ty \ˌsäl-yə-ˈbil-ət-ē\ *n* (1661) 1 : the quality or state of being soluble 2 : the amount of a substance that will dissolve in a given amount of another substance

sol·u·bi·lize \ˈsäl-yə-bə-ˌlīz\ *vt* -lized; -liz·ing (ca. 1926) : to make soluble or increase the solubility of — sol·u·bi·li·za·tion \ˌsäl-yə-bə-lə-ˈzā-shən\ *n*

sol·u·ble \ˈsäl-yə-bəl\ *adj* [ME, fr. MF, capable of being loosened or dissolved, fr. LL *solubilis*, fr. L *solvere* to loosen, dissolve — more at SOLVE] (15c) 1 a : susceptible of being dissolved in or as if in a fluid b : capable of being emulsified : EMULSIFIABLE ⟨a ~ oil⟩ 2 : subject to being solved or explained ⟨~ questions⟩

soluble glass *n* (1875) : WATER GLASS 4

soluble RNA *n* (ca. 1961) : TRANSFER RNA

so·lum \ˈsō-ləm\ *n, pl* so·la \-lə\ *or* solums [NL, fr. L, ground, soil] (1935) : the altered layer of soil above the parent material that includes the A- and B-horizons

so·lus \ˈsō-ləs\ *adv or adj* [L] (1599) : ALONE — often used in stage directions

sol·ute \ˈsäl-ˌyüt\ *n* [L *solutus*, pp.] (1902) : a dissolved substance

so·lu·tion \sə-ˈlü-shən\ *n* [ME, fr. MF, fr. L *solution-*, *solutio*, fr. *solutus*, pp. of *solvere* to loosen, solve] (14c) 1 a : an action or process of solving a problem b : an answer to a problem : EXPLANATION; *specif* : a set of values of the variables that satisfies an equation 2 a : an act or the process by which a solid, liquid, or gaseous substance is homogeneously mixed with a liquid or sometimes a gas or solid b : a homogeneous mixture formed by this process; *esp* : a single-phase liquid system c : the condition of being dissolved 3 : a bringing or coming to an end or into a state of discontinuity

solution set *n* (1959) : the set of values that satisfy an equation; *also* : TRUTH SET

So·lu·tre·an \sə-ˈlü-trē-ən\ *adj* [*Solutré*, village in France] (1888) : of or relating to an upper Paleolithic culture characterized by leaf-shaped finely flaked stone implements

solv·able \ˈsäl-və-bəl, ˈsȯl-\ *adj* (1676) : susceptible of solution or of being solved, resolved, or explained — solv·abil·i·ty \ˌsäl-və-ˈbil-ət-ē, ˌsȯl-\ *n*

¹sol·vate \ˈsäl-ˌvāt, ˈsȯl-\ *n* [*solvent* + *-ate*] (1904) : an aggregate that consists of a solute ion or molecule with one or more solvent molecules; *also* : a substance (as a hydrate) containing such ions

²solvate *vt* sol·vat·ed; sol·vat·ing (1917) : to make part of a solvate — sol·va·tion \säl-ˈvā-shən, sȯl-\ *n*

Sol·vay process \ˈsäl-ˌvā-\ *n* [Ernest *Solvay* †1922 Belg. chemist] (1888) : a process for making soda from common salt by passing carbon dioxide into ammoniacal brine resulting in precipitation of sodium bicarbonate which is then calcined to carbonate

solve \ˈsälv, ˈsȯlv\ *vb* solved; solv·ing [ME *solven* to loosen, fr. L *solvere* to loosen, solve, dissolve, fr. *sed-*, *se-* apart + *luere* to release — more at SECEDE, LOSE] *vt* (1533) 1 : to find a solution for ⟨~ a problem⟩ 2 : to pay (as a debt) in full ~ *vi* : to solve something ⟨substitute the known values of the constants and ~ for x⟩ — solv·er *n*

sol·ven·cy \ˈsäl-vən-sē, ˈsȯl-\ *n* (ca. 1727) : the quality or state of being solvent

¹sol·vent \-vənt\ *adj* [L *solvent-*, *solvens*, prp. of *solvere* to dissolve, pay] (1630) 1 : able to pay all legal debts 2 : that dissolves or can dissolve ⟨~ fluids⟩ ⟨~ action of water⟩ — sol·vent·ly *adv*

²solvent *n* (1671) 1 : a usu. liquid substance capable of dissolving or dispersing one or more other substances 2 : something that provides a solution 3 : something that eliminates or attenuates something esp. unwanted — sol·vent·less \-ləs\ *adj*

sol·vol·y·sis \säl-ˈväl-ə-səs, sȯl-\ *n* [NL, fr. E *solvent* + *-o-* + *-lysis*] (ca. 1924) : a chemical reaction (as hydrolysis) of a solvent and solute that results in the formation of new compounds — sol·vo·lyt·ic \ˌsäl-və-ˈlit-ik, ˌsȯl-\ *adj*

¹so·ma \ˈsō-mə\ *n* [Skt; akin to Av *haoma*, a Zoroastrian ritual drink, Gk *hyein* to rain — more at SUCK] (1827) 1 : an East Indian leafless vine (*Sarcostemma acidum*) of the milkweed family with a milky acid juice 2 : an intoxicating plant juice of ancient India used as an offering to the gods and as a drink of immortality by worshipers in Vedic ritual and worshiped as a Vedic god

²soma *n, pl* so·ma·ta \ˈsō-mət-ə\ *or* somas [NL *somat-*, *soma*, fr. Gk *sōmat-*, *sōma* body] (ca. 1885) 1 : the body of an organism 2 : all of an organism except the germ cells 3 : CELL BODY

So·ma·li \sō-ˈmäl-ē, sə-\ *n, pl* Somali *or* Somalis (1850) 1 : a member of a people of Somaliland apparently of mixed Mediterranean and Negroid stock 2 : the Cushitic language of the Somali people

so many *adj* (1533) 1 : constituting an unspecified number ⟨read *so many* chapters each night⟩ 2 : constituting a group or pack ⟨behaved like *so many* animals⟩

somat- *or* somato- *comb form* [NL, fr. Gk *sōmat-*, *sōmato-*, fr. *sōmat-*, *sōma* body; akin to L *tumēre* to swell — more at THUMB] : body ⟨*somato*logy⟩

so·mat·ic \sō-ˈmat-ik, sə-\ *adj* [Gk *sōmatikos*, fr. *sōmat-*, *sōma*] (ca. 1775) 1 : of, relating to, or affecting the body esp. as distinguished from the germ plasm or the psyche 2 : of or relating to the wall of the body : PARIETAL — so·mat·i·cal·ly \-i-k(ə-)lē\ *adv*

somatic cell *n* (1888) : one of the cells of the body that compose the tissues, organs, and parts of that individual other than the germ cells

so·ma·tol·o·gy \ˌsō-mə-ˈtäl-ə-jē\ *n* [NL *somatologia*, fr. *somat-* + *-logia* -logy] (ca. 1878) : a branch of anthropology primarily concerned with the comparative study of human evolution, variation, and classification esp. through measurement and observation — so·ma·to·log·i·cal \ˌsō-mət-ᵊl-ˈäj-i-kəl, sō-ˌmat-\ *adj*

so·mato·me·din \sō-ˌmat-ə-ˈmēd-ᵊn\ *n* [*somat-* + *-medin* (perh. as in *intermedin*)] (1972) : any of several endogenous peptides produced esp. in the liver and dependent on and mediating growth hormone activity (as in sulfate uptake by epiphyseal cartilage)

so·mato·pleure \sō-ˈmat-ə-ˌplu̇(ə)r\ *n* [NL *somatopleura*, fr. *somat-* + Gk *pleura* side] (1874) : a complex layer in the embryo of a craniate vertebrate consisting of the outer of the two layers into which the lateral plate of the mesoderm splits together with the ectoderm that sheathes it externally and giving rise to the body wall

so·mato·sen·so·ry \sō-ˌmat-ə-ˈsen(t)s-(ə-)rē\ *adj* (1960) : of, relating to, or being sensory activity having its origin elsewhere than in the special sense organs (as eyes and ears) and conveying information about the state of the body proper and its immediate environment

so·mato·stat·in \sō-ˌmat-ə-ˈstat-ᵊn\ *n* [*somat-* + *-stat* + *-in*] (ca. 1973) : a polypeptide neurohormone that is found esp. in the hypothalamus and inhibits the secretion of several other hormones (as growth hormone, insulin, and gastrin)